CLAIMS

1-27 (canceled)

28. (original) An adaptive system for solenoid control to achieve low impact landing with latching, with variable initial energy, and with variable path drift, comprising:

   (a) sense means, for obtaining parameters indicating the state of a controlled solenoid, said state comprising a magnetic state;

   (b) path memory means, for retrieval of predetermined information descriptive of possible low-impact landing paths in the state space of said controlled solenoid said information comprising information descriptive of magnetic state;

   (c) a variable path number, associated with said information from said path memory means, differentiating said landing paths with respect to initial energy;

   (d) a variable path drift parameter, associated with said information from said path memory means, differentiating said landing paths with respect to pattern of drift along among said landing paths;

   (e) path number determination means, for comparing said information from said path memory means with said parameters from said sense means, thereby establishing a defined path number associated with said parameters from said sense means;

   (f) loss parameter setting means, setting said variable path drift parameter;

   (g) magnetic error evaluation means, determining an error between said magnetic state of said controlled solenoid as obtained by said sense means and a magnetic state from said path memory means, corresponding to said defined path and said path drift parameter; and

(h) drive control means, responsive to said magnetic error evaluation means and setting an output signal controlling the flow of electrical energy into said controlled solenoid.

29. (original) The system of Claim 28, wherein said parameters indicating the state, obtained by said sense means, further comprise a position parameter, a velocity parameter, and a flux linkage parameter.

30. (original) The system of Claim 28, wherein said parameters indicating the state, obtained by said sense means, further comprise a position parameter, a velocity parameter, and an electric current parameter.

31. (original) The system of Claim 28, wherein the content of said path memory means is predetermined by dynamic simulations.

32. (original) The system of Claim 28, wherein said information retrieved by said path memory means is predetermined by instrumented testing of a solenoid.

33. (original) The system of Claim 28, wherein said loss parameter setting means uses predetermined information concerning the expected solenoid load, prior to an actuation cycle of said solenoid.

34. (original) The system of Claim 28, wherein said loss parameter setting means uses a path number drift parameter from a previous actuation cycle of said solenoid.

35. (original) The system of Claim 28, wherein said loss parameter setting means uses a path number drift parameter from a current, ongoing actuation cycle of said solenoid.

36. (original) A system for control of nonlinear dynamic systems
of at least third order, for reaching a target destination in a
state space from any among multiple entry points, comprising:

   (a) sense means, for obtaining parameters indicating the state
      of a controlled system;

   (b) path memory means, for retrieval of information descriptive
      of possible paths reaching a target destination in said
      state space of said controlled system;

   (c) a variable path number, associated with said information
      from said path memory means, differentiating said paths
      with respect to a measure of distance in said state space
      from said target destination;

   (d) a variable path perturbation parameter, selecting from an
      array of path perturbations associated with said path
      memory means;

   (e) path number identification means, for comparing said
      information from said path memory means with said
      parameters from said sense means, thereby defining a
      nearest path number associated with said parameters from
      said sense means and further associated with a selected
      value of said path perturbation parameter;

   (f) error evaluation means, defining a scalar error based on
      said nearest path number and on said state indicated by
      said parameters obtained by said sense means;

   (g) drive control means, responsive to said scalar error by
      controlling a variable drive input to said controlled
      system, thereby reducing said scalar error;

   (h) path drift evaluation means, quantifying a systematic drift
      from said nearest path number; and,

   (i) drift reduction means, responsive to said quantifying by
      said path drift evaluation means by setting said path
      perturbation parameter to a value that reduces said
      systematic drift.

37. (original) The system of Claim 36, wherein said measure of distance is a measure of energy change required to reach said target destination from an entry point associated with a specified value of said variable path number.

38. (new) A system for control of a solenoid actuator to achieve low impact landing with latching under varying conditions, said system comprising:

    (a) memory means for storing and retrieving predetermined trajectory information describing a multiplicity of trajectories within a state space that lead to low impact landing with latching, each of said multiplicity of trajectories corresponding to each of a multiplicity of operating conditions;

    (b) means for determining the present state of said solenoid actuator within said state space;

    (c) means for comparing said present state with said predetermined trajectory information, thereby defining a distance between said present state and a state along said multiplicity of trajectories; and

    (d) drive control means for setting an output signal in accordance with said distance;

whereby the dynamically changing state of said solenoid actuator is caused to approach a trajectory among said multiplicity of trajectories.

39. (new) The system of Claim 38, wherein a first dimension of said state space is a measure of position, said measure of position being selected from the group consisting of physical position, displacement and potential energy of said solenoid actuator.

40. (new) The system of Claim 38, wherein a second dimension of said state space is a measure of velocity, said measure of velocity being selected from the group consisting of physical

velocity, momentum and kinetic energy of said solenoid actuator.

41. (new) The system of Claim 40, wherein said measure of velocity is determined by the difference between two separate measures of position taken at two corresponding known times.

42. (new) The system of Claim 38, wherein a third dimension of said state space is a measure of the magnetic influence acting upon said solenoid actuator, said measure of magnetic influence being selected from the group consisting of flux linkage and electrical current.

43. (new) The system of Claim 38, wherein said output signal is a voltage.

44. (new) The system of Claim 38, wherein said means for determining the present state of said solenoid comprise a measured current, an applied voltage, and a flux linkage, said flux linkage inferred from time integration of an inductive voltage, said inductive voltage being determined from said measured current and said applied voltage.

45. (new) The system of Claim 44, wherein said applied voltage is established by said setting of said output signal.

46. (new) The system of Claim 44, wherein said applied voltage is determined by a known supply voltage and a pulse width modulation duty cycle.

47. (new) The system of Claim 44, wherein said measured current and said flux linkage together establish a measure of the position of said solenoid actuator.

48. (new) The system of Claim 47, wherein differences in said measure of position measured at different times constitute a measure of velocity, whereby the state of said solenoid is defined by said measure of position, said measure of velocity, and said flux linkage.

49. (new) The system of Claim 38, wherein a multiplicity of numbered trajectories leading to low impact landing with latching form in said state space a two-dimensional ribbon of sequentially numbered trajectories, each of said numbered trajectories corresponding to a mechanical energy of said solenoid, and wherein said drive control means causes said dynamically changing state to approach said ribbon, said drive control means further comprising a means to measure systematic drift across said ribbon amongst said numbered trajectories and thereby define a drift error.

50. (new) The system of Claim 49, wherein said drift error is used to modify said predetermined trajectory information.

51. (new) The system of Claim 49, wherein said drift error is used to select and retrieve a separate multiplicity of numbered trajectories forming a new ribbon which better matches predictive perturbations that are distinct from said operating conditions and are descriptive of present mechanical energy arising from past events.

52. (new) A method for solenoid control to achieve low-impact landing, comprising the steps of:
(a) testing, wherein a test system having response characteristics like those of the solenoid to be controlled is caused to execute test trajectories of differing initial energies that achieve low-impact landings, said low-impact landings including latching and having a speed of impact below a prescribed maximum speed;

(b) path function calibration, wherein parameters of path
    functions are set such that said path functions describe
    said test trajectories that achieve said low-impact
    landing;

(c) calibration programming, wherein a solenoid controller is
    programmed to recall said path function calibration;

(d) response comparison programming, wherein said solenoid
    controller is further programmed to make a comparison
    between a measured solenoid response and at least one of
    said test trajectories described by said path functions;
    and

(e) drive control programming, responsive to said comparison by
    controlling an electrical drive signal as part of the
    actuation of said measured solenoid.

53. (new) The method of Claim 52, wherein said test system is a
mathematical simulation generating simulated response
characteristics analogous to said response characteristics like
those of the solenoid to be controlled.

54. (new) The method of Claim 52, wherein said test system is
an actual solenoid with instrumentation to measure said
trajectories.

55. (new) The method of Claim 52 wherein said path functions
define points in a multi-dimensional space of state space
variables.

56. (new) The method of Claim 55, wherein the dimensions of
said space are transformable into the dimensions of position,
velocity, and flux linkage.

57. (new) The method of Claim 56, wherein said dimensions are a measured position, a difference between measured positions, and a cumulative total of inductive voltages.

58. (new) The method of Claim 57, wherein said inductive voltages are voltages measured from a sense coil;

59. (new) The method of Claim 57, wherein said inductive voltages are computed from an applied voltage, an electrical current, and a resistive voltage that is a function of said current.

60. (new) The method of Claim 59, wherein said applied voltage is computed from supply voltage information and from the duty cycle of a pulse width modulator.

61. (new) The method of Claim 59, wherein said current is measured using a sense resistor.

62. (new) The method of Claim 60, wherein said value of resistive voltage is said electrical current multiplied by a resistance.

63. (new) The method of Claim 52, wherein said drive control programming comprises determination of a flux linkage projected into the future relative to a measurement time of said measured solenoid response.

64. (new) The method of Claim 52, wherein said drive control programming comprises determination of a voltage to be generated in a future period of time relative to a measurement time of said measured solenoid response.